INSTRUCTION MANUAL
FOR...

TRANSCEIVER
MODEL HT-2A

the hallicrafters co.

A Subsidiary of Northrop Corporation

INSTRUCTION MANUAL
FOR
MODEL HT-2A
TRANSCEIVER

Manufactured By:

The Hallicrafters Co.
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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I
INTRODUCTION

1. PURPOSE OF EQUIPMENT.

2. The Hallicrafters Transceiver Model HT-2A transmits and receives AM (Amplitude Modulated) signals in the 30 to 40 megacycle frequency range in the GROUND TO GROUND position and in the 115 to 135 megacycle frequency range in the AIR TO GROUND position. The frequency of operation in GROUND TO GROUND position is compatible with that of the Village Radio Transceiver Model TR-20 and, when properly netted to the channel frequency, may be used in conjunction with Model TR-20 to provide communications between base and field units. The frequency of operation in AIR TO GROUND position is compatible with aircraft units and may be netted with aircraft channel frequencies.

NOTE

It is recommended that this instruction manual be read completely to ensure familiarity with the transceiver before attempting to place the equipment in operation.

3. FUNCTIONAL DESCRIPTION.

4. The transceiver is designed for operation from self contained batteries providing 12 volts DC or an external 12-volt DC supply, such as a storage battery. The circuits of the transceiver are completely transistorized to minimize current drain.

5. PHYSICAL DESCRIPTION

6. The transceiver, shown in figure 1, is compact, lightweight, and rugged in construction. The sealed case prevents moisture damage to the equipment. No external connections are necessary to the equipment for normal field operation. However, when desired, connections for external antenna, headset, and external 12-volt DC supply are made at the top of the unit to the jacks provided. The transceiver is equipped with hand and shoulder carrying straps. The unit is approximately 11-1/2 inches high, by 4 inches deep, by 2-3/4 inches wide, excluding the telescoping antenna at the side. The antenna, when extended, is approximately 74 inches in length. Weight of the unit is approximately 5 pounds, including batteries.

SECTION II
SPECIFICATIONS

7. Specifications applicable to the transceiver are presented in table I. The transistor and diode complement is listed in table II. The required fuses are listed in table III. The dimensions and weight are given in preceding paragraph 6.

Table I. Specifications.

GENERAL:

Input power - 12 volts DC, 0.180 amperes (transmit)

Transmit cycle - 1 minute transmit, 4 minutes receive, on a continuous basis

TRANSMITTER:

Power output - 0.5 watt (minimum)

Emission - AM (amplitude modulated) voice

Frequency range - 30 to 40 megacycles (GROUND TO GROUND)
115 to 135 megacycles (AIR TO GROUND)

Number of channels - 2 (both crystal controlled)

Frequency stability - ±0.005%

Output impedance - 50 ohms (nominal) to external antenna jack

Table I. Specifications (CONT).

RECEIVER:

Superheterodyne circuit (transistorized) (double conversion)

Frequency range - 30 to 40 megacycles (GROUND TO GROUND)
115 to 135 megacycles (AIR TO GROUND)

Number of channels - 2 (both crystal controlled)

Frequency stability - ±0.005%

Selectivity (6 DB down) - 27 kilocycles minimum

Sensitivity - 1.5 microvolts for 10 DB $\frac{\text{signal + noise}}{\text{noise}}$ (GROUND TO GROUND)

2.5 microvolts for 10 DB $\frac{\text{signal + noise}}{\text{noise}}$ (AIR TO GROUND)

1st Intermediate Frequency - 14.4 megacycles

2nd Intermediate Frequency - 455 kilocycles

Input impedance - 50 ohms (nominal) at external antenna jack

Audio output to speaker - 500 milliwatts (peak output)

Squelch - adjustable threshold type

Standby current (no signal) - 25 milliamperes (GROUND TO GROUND); 35 milliamperes (AIR TO GROUND)

Table II. Transistor and Diode Complement.

Reference Symbol	Type	Function
RECEIVER SECTION GROUND TO GROUND		
Q1	2N2654	RF Amplifier
Q2	2N2654	First Converter
Q3	2N2654	Second Converter
Q4	2N2672	First IF Amplifier
Q5	2N2672	Second IF Amplifier
Q6	SA536	Squelch Amplifier
D1	1N270	Detector
D2	1N270	Squelch Rectifier
D3	1N295	Protective Diode
D4	1N295	Noise Limiter Diode

Table II. Transistor and Diode Complement (CONT).

Reference Symbol	Type	Function
RECEIVER SECTION AIR TO GROUND		
Q401	2N3283	RF Amplifier
Q402	2N3283	Mixer
Q403	2N2654	IF Amplifier
Q404	2N3285	Local Oscillator
AUDIO AND MODULATION SECTION		
Q7	SA536	First Audio Amplifier
Q8	SA536	Driver Amplifier
Q9	2N2431	Audio Output and Modulator
Q10	2N2431	Audio Output and Modulator
TRANSMITTER SECTION GROUND TO GROUND		
Q11	SM8554	Transmitter Oscillator
Q12	SM8543	Transmitter Power Amplifier
TRANSMITTER SECTION AIR TO GROUND		
Q405	2N3553	Transmitter Power Amplifier
Q406	2N3866	Transmitter Driver
Q407	2N3298	Transmitter Oscillator

Table III. Fuse Complement.

Reference Symbol	Type	Function
F1	0.125 ampere	Destruct Fuse

SECTION III

INSTALLATION AND ADJUSTMENT

8. UNPACKING.

9. The equipment may be shipped in either export or domestic packing cases. In either event, no special unpacking procedures are necessary. When new equipment is received, select a location where the cases may be unpacked without exposure to adverse weather conditions.

10. PRELIMINARY PROCEDURES. Complete the following steps to prepare equipment for use.

a. Remove the Air/Ground Adapter from the front of the unit by removing the three screws at the front and pulling the adapter out from the transceiver. It may be necessary to "rock" the adapter to disengage the connector.

b. Remove bottom cover plate by loosening the single screw at the center of plate.

c. Lift latching spring, located in the center of battery compartment, above latch button and simultaneously slide the unit out of case by pulling the top end plate.

d. Remove air to ground printed circuit board from adapter by removing knob with Allen wrench provided, and hex nut from switch. Inspect components for possible damage incurred in shipment. Report damages immediately to responsible personnel. DO NOT ATTEMPT TO PLACE DAMAGED EQUIPMENT IN SERVICE.

e. Do not replace unit in case at this time. Observe battery installation decal or figure 2 and install eight (8) size "D" cells as shown. Secure lower end plate in place temporarily with the single screw to secure batteries in place and complete the battery circuit.

NOTE

Follow battery installation diagram carefully. Improper battery installation will result in shortened battery life, improper or no voltage conditions. The battery case is designed to prevent reverse battery installation, however, extreme care should be exercised.

11. OPERATIONAL CHECK. A rapid operational check of the transceiver may be made, providing the unit is equipped with crystals installed, by completing steps a through d for receiver circuits and steps e through g for transmitter circuits.

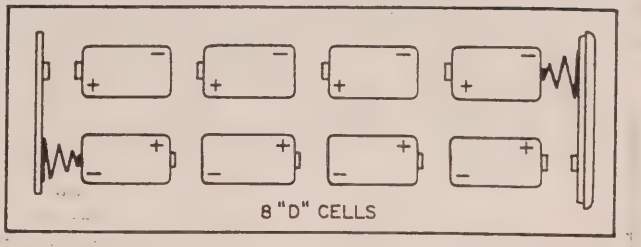


Figure 2. Battery Installation Diagram.

a. Connect a signal generator to EXT ANT receptacle J2.

b. Turn the channel switch to GROUND TO GROUND position.

c. Tune the signal generator to the channel frequency in use and apply a modulated RF signal. An input signal of 1 microvolt is sufficient to produce an audible output at the loudspeaker.

d. Turn the channel switch to AIR TO GROUND position and check receiver as in step c.

e. Disconnect signal generator from transceiver and fully extend the telescoping antenna.

f. Place channel switch to GROUND TO GROUND position and using a Model FS-1 Field Strength Meter as an RF output indicator, depress the push-to-talk button. Meter should deflect upward, indicating presence of RF.

g. Place channel switch in AIR TO GROUND position, and using a grid dip meter, check for presence of RF output by depressing push-to-talk button and tuning grid dip meter to channel frequency.

12. TEST EQUIPMENT. The following test equipment will be required to complete the adjustment procedures:

a. Test Set, Model TS-20/35.

b. Accessory kit to the TS-20/35, Model K-1 which includes adapter cable and test plug.

c. Signal generator, covering the 455 kilocycle to 135 megacycle frequency range.

d. RF wattmeter, or suitable dummy load with 50 ohm input impedance and provisions for metering the output.

e. Vacuum tube voltmeter (HP-410B or equivalent).

f. Audio vacuum tube voltmeter (Heathkit IM-21 or equivalent).

g. Probe-T-connector HP-455A or equivalent.

h. 12-VDC power supply.

i. Frequency meter or similar frequency measuring equipment to check operating frequency.

j. Field Strength Meter Model FS-1 or similar meter for adjusting antenna loading for maximum radiated power.

k. Grid dip meter (Measurements Corp. Model 59 or equivalent).

l. Audio output power meter (General Radio Model 583-A or equivalent).

13. TEST SET MODEL TS-20/35. The Hallicrafters Model TS-20/35 Test Set, shown in figure 3 with adapter cable and test plug, is designed for use with equipment of this type. The schematic diagram is shown in figure 14. The 500 microampere meter is provided with a special scale divided into red and green segments. The special scale permits rapid checking of equipment operation by semi-skilled operators. The test set checks the 5 circuits listed in table IV by merely positioning a rotary selector switch. The equipment may be checked in ground to ground operation only when using the test set. The green area is a target area unless otherwise specified. However, an indication slightly into the red area does not necessarily indicate that the transceiver is not functioning properly. When a large variation from the green area occurs, the transceiver should be checked by a skilled technician. The following steps describe test set connection and use:

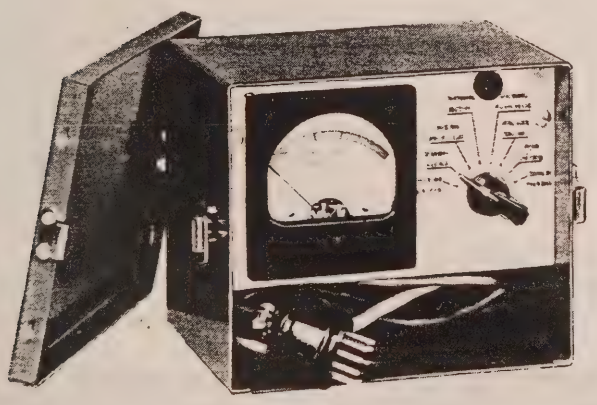
a. Connect the eleven pin connector on test set to the mating connector of the adapter cable and the adapter cable tip plug to the pin jack located above test set selector switch.

b. Connect the test set adapter cable to test socket S1 on the transceiver for completion of set-up procedures.

c. Connect the test plug, part NO. 150-016238 to socket S2. If plug is not available, refer to figure 7 and, using 20 gauge bare wire, make the connections shown on socket S2.

CAUTION

The TS-20/35 Test Set is a sensitive instrument. Use care in operation during alignment and measuring to prevent overload damage.



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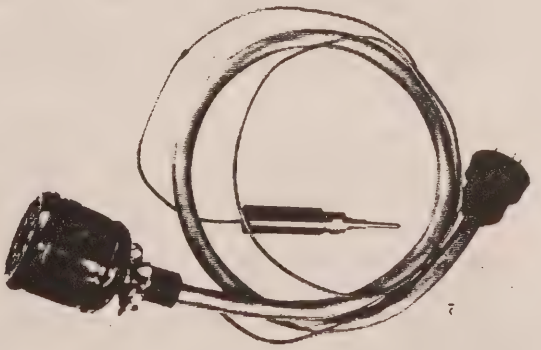

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Figure 3. Model TS-20/35 Test Set, Adapter Cable, and Test Plug.

Table IV. Test Set TS-20/35, Switch Positioning and Indications.

Position	Test Function	Indication
1	Battery voltage	Green
2	Not used	
3	AGC voltage	Note 1
4	Transmitter oscillator current	Green
5	Transmitter power amplifier current	Green
6	Not used	
7	Not used	
8	Modulator current	Note 2

NOTES

1. In position three, correct reading will be in the green area under no signal conditions, application of a signal causes the needle to deflect left indicating proper AGC operation.

2. In position eight, normal reading will be to the extreme left in the red area under no modulation conditions. Speaking into the microphone with push-to-talk button depressed will cause the pointer to deflect into the green area on voice peaks.

14. FIELD STRENGTH METER MODEL FS-1. The Model FS-1 Field Strength Meter shown in figure 4 is designed for use with the transceiver and similar equipment in the 30 to 40 megacycle frequency range. The schematic diagram is shown in figure 14. The following steps will aid the user in obtaining optimum performance and results with the field strength meter:

a. Extend the telescoping antenna and insert the plug on the antenna in the receptacle through top of case. See figure 4.

b. Place field strength meter on the ground or table and set frequency tuning control to the approximate known frequency of operation.

c. Moving a reasonable distance away from the field strength meter with the transceiver, observe field strength meter and press push-to-talk button; meter should deflect upward indicating presence of the RF output.

d. Complete tune-up and adjustment procedures as specified, tuning for maximum indication on the meter.

e. The Model FS-1 sensitivity may be reduced, if necessary, by detuning the input circuit with the tuning control.

15. LOCATION AND FUNCTION OF CONTROLS.

16. Table V lists the reference designation, item name or marking, and the function of controls on the transceiver. Figure 5 shows their locations.

17. ALIGNMENT.

18. In the event that the transceiver is not equipped with crystals and/or requires realignment for any reason, disassemble the transceiver as outlined in paragraph 10, steps a through d. The following paragraphs contain alignment procedures: Paragraph 19 covers alignment of the receiver ground to ground circuits, paragraph 20, the transmitter ground to ground circuits; paragraph 21, the receiver air to ground circuits; and paragraph 22, the transmitter air to ground circuits.

19. RECEIVER GROUND TO GROUND CIRCUIT ALIGNMENT. Complete the following steps to align the receiver ground to ground circuits:

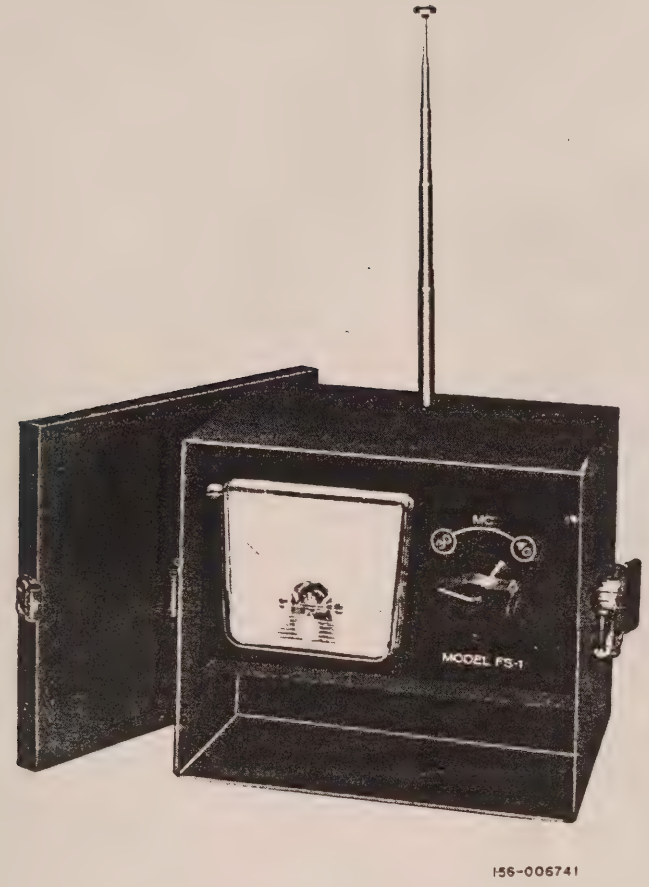


Figure 4. Model FS-1 Field Strength Meter.

a. Refer to figure 6 and install crystal CR1 for the selected channel frequency. The crystal frequency is the operating frequency minus 14.4 megacycles. Crystals are marked with channel frequency and preceded by the letter "R" to denote receiver crystals.

EXAMPLE

34.950 MC desired channel frequency

-14.400 MC difference frequency

20.550 MC crystal frequency (actual)

b. Insert a test plug, part NO. 150-016238, for use with the transceiver, into socket S2. If the test plug is not available, the pins on socket S2 must be connected (jumpered), using small loops of 20 gauge bare wire, as shown in figure 7.

c. Connect the TS-20/35 test set to socket S1 using the test set adapter cable.

d. Place the test set selector switch in the number 1 position (Battery Voltage). Refer to figure 5 and place the OFF-ON switch SW1 in the ON position, and observe meter for proper indication of battery voltage (green target area).

Table V. Transceiver Control Functions.

Reference Designation	Item Name or Marking	Function
R31	VOLUME Control	Controls audio output level of receiver.
R32	SQUELCH Control	Establishes threshold of squelch circuit to mute receiver in absence of signal.
SW1	OFF-ON Switch	Applies or removes operating voltages to equipment.
SW2	Push-to-Talk Button	Switches operating voltage from receiver to transmitter circuits; switches antenna from receiver to transmitter; converts audio circuits to modulating circuits.
SW401	GROUND TO GROUND-AIR TO GROUND Switch	Selects GROUND TO GROUND or AIR TO GROUND communications channel.
	(For units equipped with the destruct circuit.)	
SW3	Destruct Button	Equipment disabling. Functions only when push-to-talk switch is depressed, transmit condition.

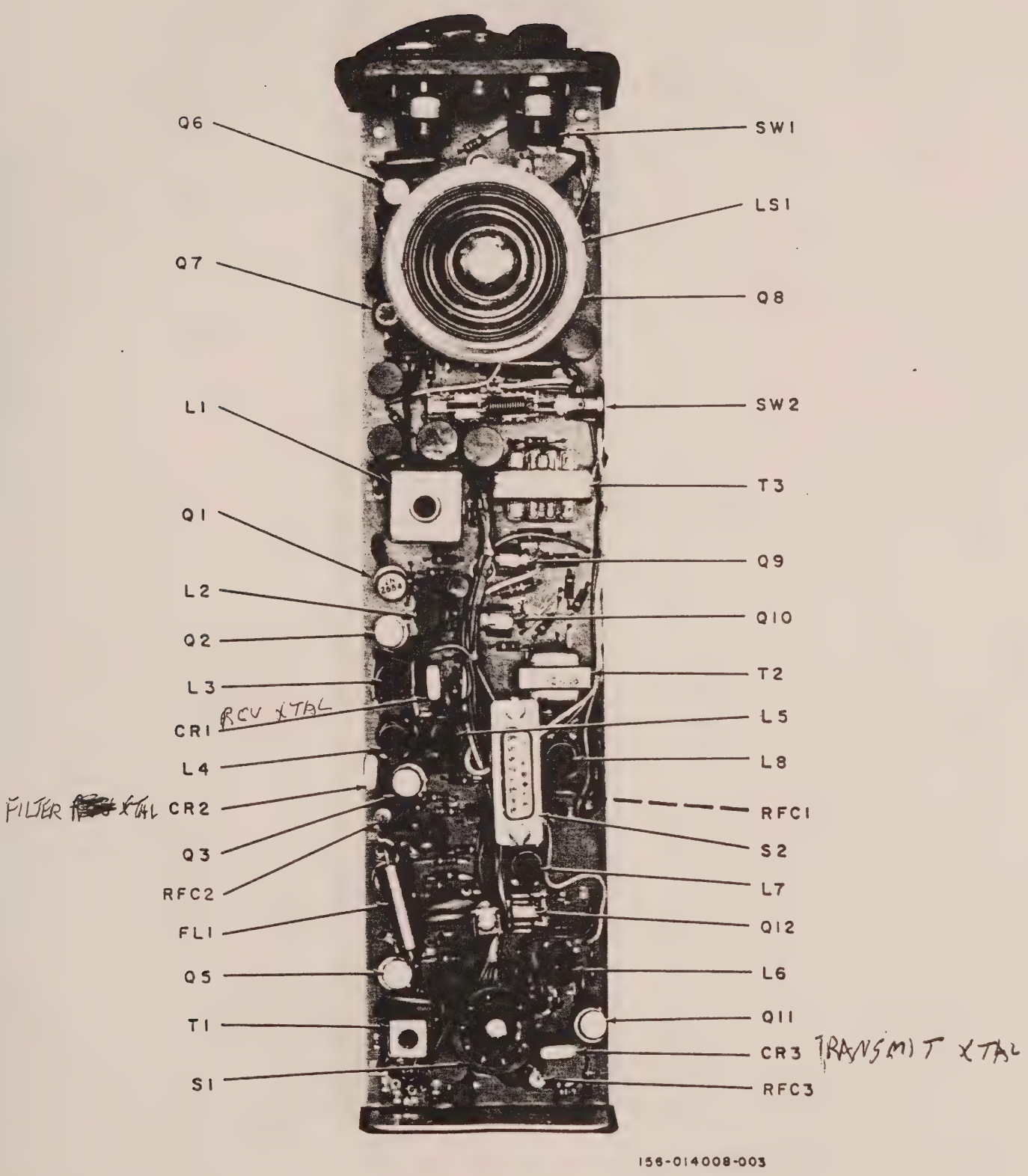


Figure 6. Location of Crystals and Adjustments (Ground to Ground Circuits).

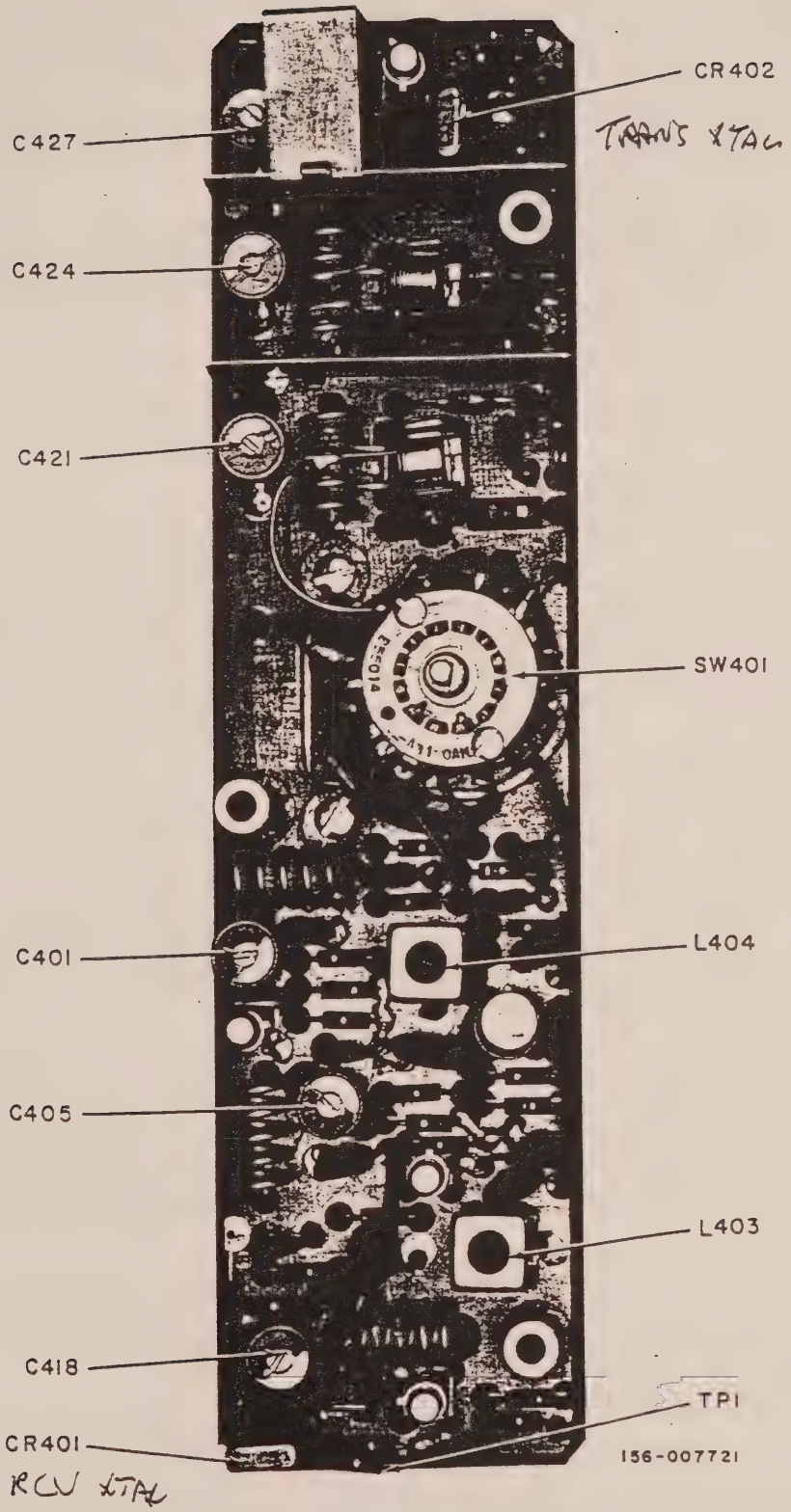


Figure 8. Location of Crystals and Adjustments (Air to Ground Circuits).

EXAMPLE

119.100 MC desired channel frequency

-14.400 MC difference frequency

104.700 MC crystal frequency (actual)

c. Disconnect telescoping antenna lead plug P1 at internal pin jack S3 and slide the unit into the case.

d. Insert Air/Ground Adapter board in socket S2 and replace the three screws to hold the board in place. DO NOT REPLACE AIR/GROUND ADAPTER COVER AT THIS TIME.

e. Turn the transceiver channel switch clockwise (AIR TO GROUND position). Connect a signal generator to EXT ANT receptacle J2 and tune the signal generator to the channel frequency being used (115 to 135 MC).

f. Refer to figure 8 and, using an insulated alignment tool, adjust oscillator tank capacitor C418 for an audible output at the loudspeaker. If difficulty is encountered in adjusting capacitor C418 for proper frequency of oscillation, a grid dip meter may be used to locate the correct frequency. Tune the grid dip meter to a frequency corresponding to the channel frequency minus 14.4 MC and loosely couple the grid dip meter to oscillator tank coil L406 and adjust capacitor C418 for an indication on the grid dip meter. Connect a VTVM probe to test point TP1 (refer to schematic diagram, figure 14). Slowly adjust capacitor C418 for maximum negative voltage. Reading should be approximately minus 3 volts. The oscillator must be operating at the correct frequency before the remaining receiver circuits can be aligned.

g. Connect an audio output power meter to EXT PHONE jack J3, using a miniature 2-conductor phone plug. Set impedance of the output power meter to 50 ohms. Tune the signal generator to the channel frequency and adjust the generator output level for a reading of approximately 150 milliwatts on the output power meter.

h. Adjust antenna and amplifier tank capacitors C401 and C405 for maximum output, reducing the generator output to maintain the 150 milliwatt output reading.

i. With the signal generator still set at the channel frequency, adjust IF coils L403 and L404 for maximum output.

j. Repeat steps e through i for optimum receiver alignment.

22. TRANSMITTER AIR TO GROUND CIRCUIT ALIGNMENT. Complete the following steps to align the transmitter air to ground circuits.

a. Install crystal CR402 at the location shown in figure 8. The crystal frequency is the actual operating frequency. Crystals are marked with the channel frequency and are preceded by the letter "T" to denote transmitter crystals.

b. Connect an RF VTVM and a 50-ohm dummy load to the output sides of a probe-T-connector. Connect the input side of the probe-T-connector to EXT ANT receptacle J2. Set VTVM to 10-VAC range.

c. Depress push-to-talk button and adjust oscillator tank capacitor C427 to tune the oscillator to the channel frequency (115 to 135 MC), using the grid dip meter as a receiving detector.

d. With the push-to-talk button depressed, tune the driver tank capacitor C424 for maximum indication on the VTVM.

e. With the push-to-talk button depressed, tune the power amplifier tank capacitor C421 for maximum indication on the VTVM.

f. With the push-to-talk button depressed, retune capacitors C421, C424 and C427 for maximum indication on VTVM. The output reading on the VTVM should be 5.0 to 5.5 volts, corresponding to 0.5 to 0.6 watt.

g. Disconnect VTVM, dummy load and probe-T-connector from the transceiver.

h. Check receiver and transmitter for correct operating frequency using a frequency measuring device of known accuracy. The transmitter and receiver crystals should oscillate within ±0.003% of their actual frequencies. The frequency of both oscillators may be changed slightly by a small adjustment of the oscillator circuit tank capacitors.

i. When the Air/Ground Adapter circuits have been properly aligned, depress the push-to-talk button several times to check transmitter oscillator starting ability. In the event the oscillator does not start, repeat steps c through h.

j. Remove the three screws securing the Air/Ground Adapter board. Remove the board from socket S2. Slide unit out of case and connect the telescoping antenna lead plug P1 at internal pin jack S3. Reassemble the transceiver in the reverse order of steps a through d, paragraph 10.

NOTE

If the transceiver is to be operated with an external 50-ohm antenna, telescoping antenna plug P1 should be disconnected from pin socket S3. When operating into the telescoping antenna, P1 should remain in pin socket S3.

SECTION IV
OPERATION

23. GENERAL. The transceiver is assumed to be adjusted in accordance with the instructions contained in the preceding section.

24. OPERATION.

25. STARTING. Extend the telescoping antenna to its full height and place the OFF-ON switch SW1 in the ON position. Set switch SW401 to desired channel of operation.

Figure 9. Proper Method of Operation.

26. RECEIVER. The receiver is operative upon application of power, and requires only adjustment of audio level VOLUME control and adjustment of SQUELCH control to mute the receiver when a signal is not being received. The SQUELCH control will normally not require resetting unless attempting to receive an extremely weak signal of insufficient amplitude to break the squelch.

27. TRANSMITTER. Operate the transmitter by depressing the push-to-talk button at the side of the case and speak distinctly and clearly into the microphone/ speaker. Figure 9 illustrates the proper method of operating and positioning equipment to properly modulate the output. Adjustments are not necessary on the transmitter during or preceding operation when previously pretuned and set in accordance with preceding instructions of Section III.

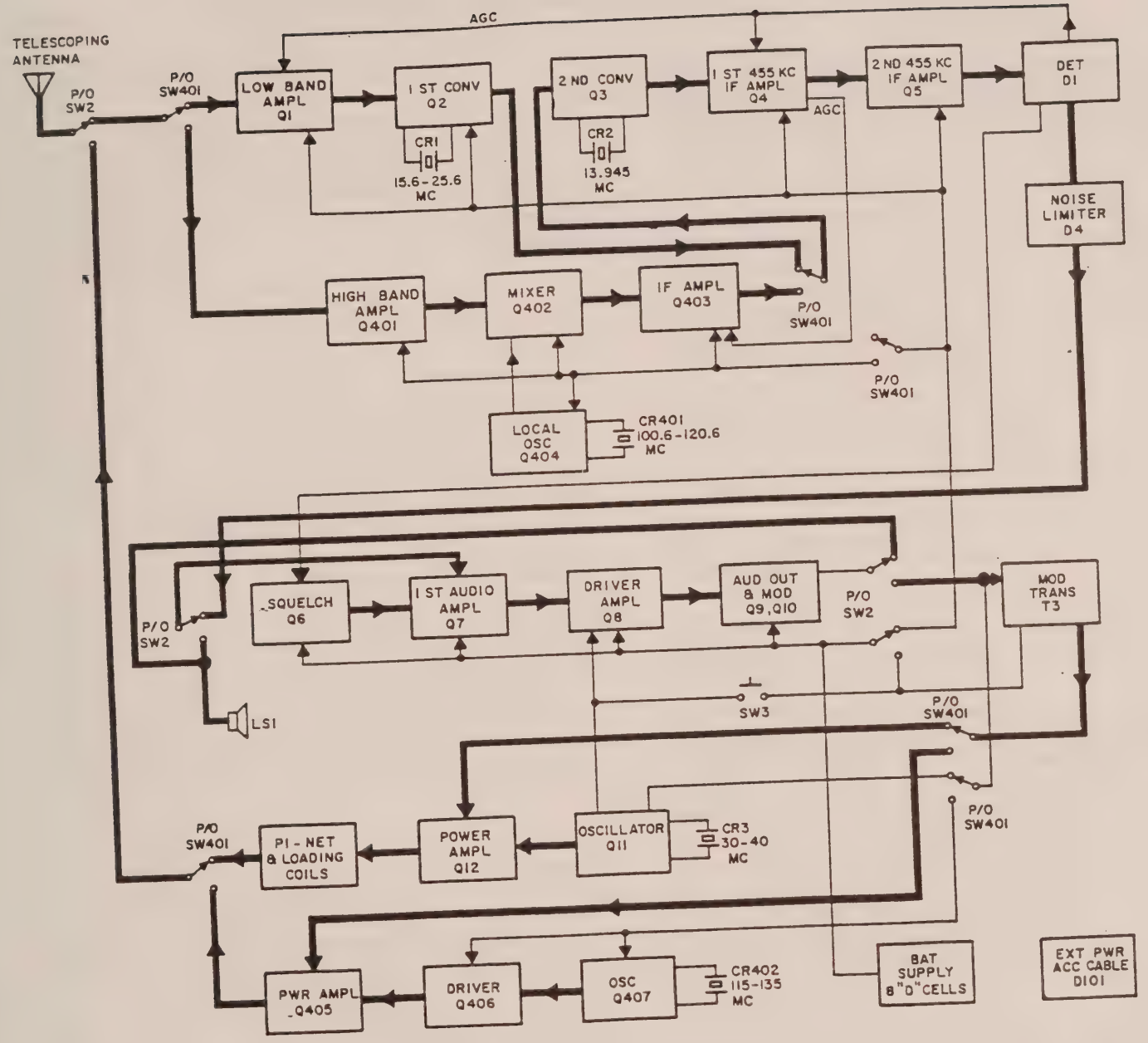
28. The receiver returns immediately to operation when push-to-talk button is released, antenna change-over and muting is accomplished by the switching action of push-to-talk button.

*29. DESTRUCTION TO PREVENT UNAUTHORIZED USE. Some transceivers are provided with a destruct circuit which disables the equipment to prevent unauthorized use of the receiver and transmitter. Destruction is accomplished by pressing the destruct button on the top end plate, while the push-to-talk button is pressed to transmit and the OFF-ON VOLUME is in the ON position. Accidental destruction is prevented by the interlocking action required and the accessibility of the destruct button to accidental contact.

30. The equipment is turned off when OFF-ON switch SW1 is rotated to the extreme counterclockwise position.

31. OPERATION CHECKS. The equipment requires no operating checks during or before operation when properly pre-aligned and tuned according to instructions in Section III.

*Applicable to those units equipped with destruct circuit.



NOTES:

1 - SW2 PTT SWITCH IN RECEIVE CONDITION.

2 - SW401 CHANNEL SWITCH IN GROUND TO GROUND POSITION.

3 - SIGNAL PATHS INDICATED BY HEAVY LINES.

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Figure 10. Block Diagram.

SECTION V
PREVENTIVE AND CORRECTIVE MAINTENANCE

32. INTRODUCTION.

33. The successful and rapid application of preventive and corrective maintenance procedures require a thorough understanding of the theory of operation of the transceiver. The following paragraphs must be studied carefully before preventive or corrective maintenance procedures are attempted.

34. THEORY OF OPERATION.

35. The transceiver consists of a main case which houses the 27 TO 50 MC transmitter and receiver circuits, the common audio circuits and the power source. The Air/Ground Adapter circuits (115 to 135 MC) are housed in the cover, mounted on the main case, front cover plate. The audio circuits and power source function in both receive and transmit conditions and are common to both communications channels. The air to ground receiver circuits operate independently of the ground to ground receiver circuits, that is, the ground to ground RF amplifier and converter stages Q1 and Q2 are bypassed. The Air/Ground Adapter also contains a crystal-controlled, 3-stage transmitter which operates independently of the ground to ground transmitter. Power and modulation is supplied from the main case. Switch SW401 selects either the GROUND TO GROUND or AIR TO GROUND communications channel.

36. BLOCK DIAGRAM. The signal path through the transceiver is shown in the over-all block diagram, figure 10. Paragraph 37 covers the signal path through the receiver circuits while paragraph 38 covers the transmitter signal path. For overall circuit details refer to the schematic diagram shown in figure 14.

37. RECEIVER CIRCUITS. The receiver circuits operate from the 12-volt DC supply. Sub-paragraphs a through g cover the [illegible] circuits and sub-paragraphs h through k cover the 115 to 135 MC circuits.

a. RF amplifier stage Q1 in a common emitter circuit, utilizing a low noise transistor, is designed to amplify a frequency in the 30 to 40 megacycle range. Diode D3 protects transistor Q1 from overload in the presence of strong signals. Output from the RF amplifier is coupled to the first converter stage through coil L2.

b. First converter stage, transistor Q2, functioning as both a mixer and a crystal-controlled tickler coil oscillator, operates at a frequency 14.4 megacycles below the incoming frequency. The output is coupled through band-pass coupler coils L4 and L5, tuned to 14.4 megacycles, to the input of the second converter stage.

c. Second converter stage, transistor Q3, is also a combination mixer/oscillator circuit. In this stage, the crystal operates in the fundamental mode in a crystal controlled Pierce oscillator circuit. The oscillator operating at 13.945 megacycles mixes with the 14.4 MC IF signal to develop a difference frequency of 455 KC for application to the first 455KC IF amplifier.

d. The output of second IF amplifier, transistor Q5, is developed across transformer T1. The developed output is detected by diode D1 and applied to the audio input through noise limiting diode D4, AGC circuit and squelch amplifier circuit transistor Q6. The audio is applied to first audio amplifier transistor Q7 through VOLUME control R31.

e. The AGC voltage developed at the output of detector diode D1 is applied through the decoupling and filter network to the receiver bias circuits.

f. The squelch amplifier, transistor Q6, is biased in a manner determined by the setting of SQUELCH control R32, in the emitter circuit, to permit "turn-on" and "turn-off" at the first audio amplifier. During the absence of a signal, transistor Q6 is in an "on" condition developing forward bias on diode D2 and biasing the first audio amplifier to cutoff. With the presence of a signal at the base of transistor Q6, the transistor turns "off" removing forward bias on squelch detector diode D2 and biasing the first audio amplifier permitting it to function in a normal manner.

g. The audio signal applied to first audio amplifier transistor Q7 is amplified and capacitively coupled to the driver amplifier transistor Q8 for further amplification. The output of the driver amplifier is transformer coupled to the audio output stage for amplification to the necessary level. The audio output modulator stage function as a push pull class B output stage with each transistor conducting on alternate half cycles of the signal, for driving the loudspeaker or an external speaker or headset connected to EXT PHONE receptacle J3.

h. With switch SW401 in AIR TO GROUND position, signals are amplified by RF amplifier

stage Q401 in a low-noise, common-emitter circuit. AGC is not applied to the RF amplifier Q401 because the IF AGC is adequate in this range. The output is coupled through coil L402 to the mixer.

i. Mixer stage Q402 combines the signal from RF amplifier Q401 with the signal from the local oscillator.

j. Local oscillator Q404 is a fifth overtone crystal-controlled oscillator operating at a frequency 14.4 MC lower than the incoming signal.

k. The mixer output is applied to the IF amplifier stage Q403 through coil L403. The output of the IF amplifier is coupled to second converter stage Q3 through SW401, P401 and S2. The signal flow is then identical to that in subparagraphs c through g.

38. TRANSMITTER CIRCUITS. The transmitter circuits operating from the self-contained 12-volt battery supply function as follows:

a. The ground to ground transmitter oscillator, transistor Q11, develops the carrier across coil L6 in a common-emitter configuration, crystal-controlled oscillator circuit. The output is coupled to the base circuit of the transmitter power amplifier.

b. The transmitter power amplifier, transistor Q12, in a common-emitter configuration, amplifies the signal applied to the base. Modulation is applied through RF choke RCF1 in the 12V supply circuit. The output is developed across the Pi-network and coupled through switch SW401 to the antenna circuit.

c. Audio amplification and modulation circuits in the transmit mode function as follows: Microphone/Speaker LS1 is capacitively coupled to the input of the first audio amplifier, transistor Q7. The output is amplified through first audio amplifier transistor Q7, driver Q8 and applied to the audio output and modulator section. The output of the audio modulator is developed across modulation transformer T3 and applied to the emitter circuit of the transmitter power amplifier to provide a modulating signal to the transmitter circuit.

d. Depressing the destruct switch with the transceiver operating in the transmit mode causes excess current to flow through fuse F1 in the emitter circuit of transistor Q8. Therefore the fuse will blow, preventing generation of a carrier signal. Disability of the transmitter and receiver circuits renders the equipment inoperative.

e. The air to ground carrier is generated by oscillator stage Q407, a fifth overtone, crystal-controlled oscillator similar to oscillator stage Q11.

f. The oscillator output is coupled through coil L411 to the driver stage Q406. The output of the driver is coupled through coil L409 to the power amplifier stage Q405 and through switch SW401 to the antenna circuit.

39. POWER SUPPLY. The power supply consisting of eight size "D" cells develops 12 volts for operation of the equipment. The positive terminal of the battery is at ground while the negative terminal is the high side in this equipment. When using an external battery supply, such as a 12-volt automotive battery, or similar 12-volt DC supply source, external voltage is applied through EXT BAT receptacle J1 and accessory cable consisting of a polarity protect diode D101 and fuse F101. Observe battery polarity when connecting to an external battery.

40. CORRECTIVE MAINTENANCE.

41. GENERAL. Corrective maintenance involves two basic procedures; localization of trouble and isolation. Localization means tracing the trouble to the circuit responsible for abnormal operation. Isolation means tracing the trouble to the defective component. Quite frequently, the source of trouble can be isolated by inspection of components and wiring.

42. TROUBLE SHOOTING.

43. TROUBLE LOCALIZATION. The localization of trouble is most easily accomplished by performing the adjustment procedures of Section III and noting the results or indication for comparison with the normal condition. This will frequently locate the trouble.

CAUTION

Care must be exercised when using an ohmmeter in the testing of transistorized equipment. The application of ohmmeter test leads between emitter and base may damage the transistor due to reverse polarity voltage application from the meter. Check polarity of probes before testing if not known.

44. TROUBLE ISOLATION. The isolation of trouble to the defective part is most easily accomplished by the use of a vacuum tube voltmeter or volt-ohmmeter and normal transistor servicing techniques. Reference to the voltage charts in table VI facilitates rapid determination of the part at fault. During the process of isolation, continuous reference must be made to the schematic diagram to determine circuit configuration. The following sub-paragraphs cover basic

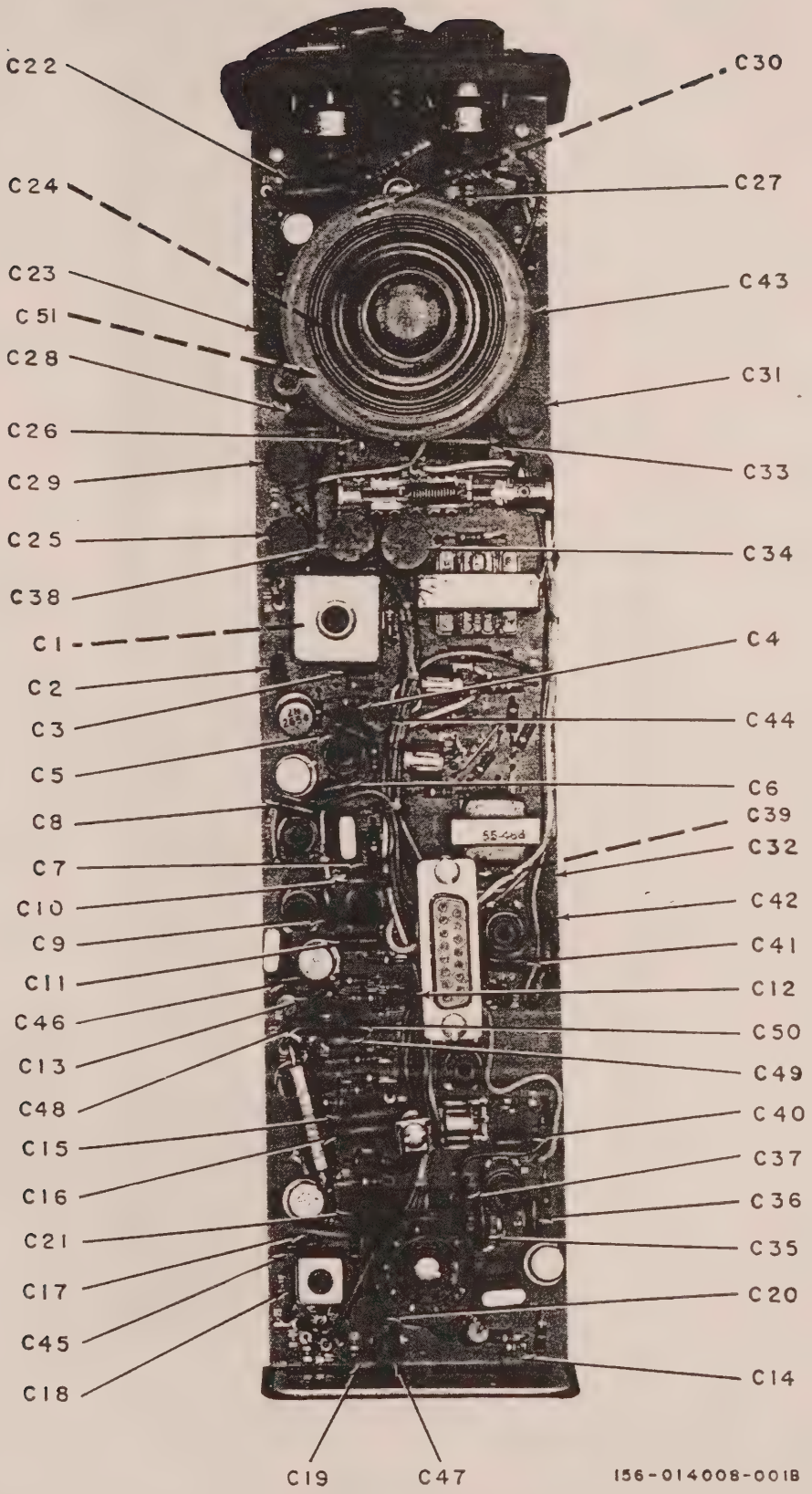


Figure 11. Component Locations (Ground to Ground Printed Circuit Board) (Sheet 1 of 2).

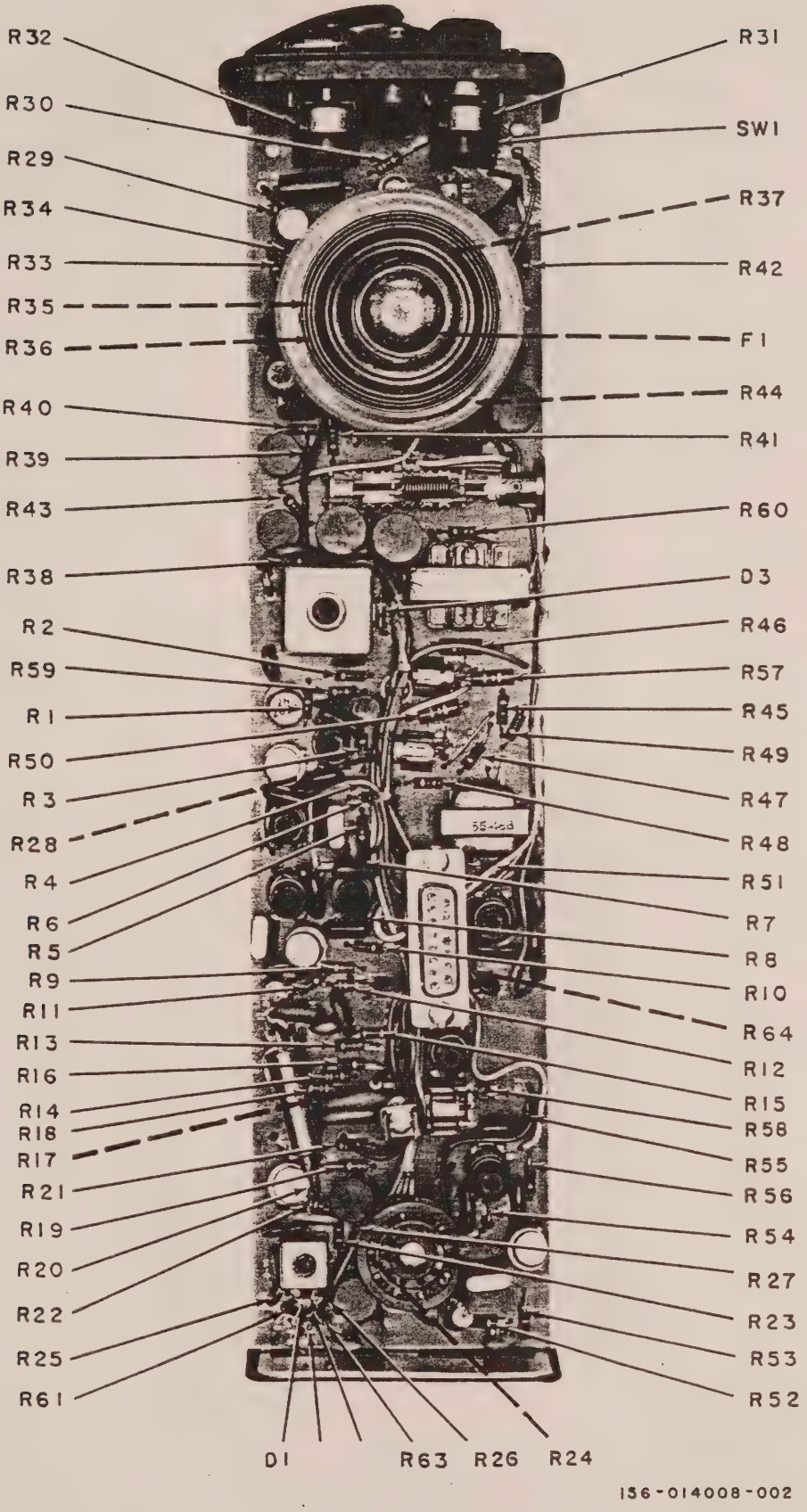


Figure 11. Component Locations (Ground to Ground Printed Circuit Board) (Sheet 2 of 2).

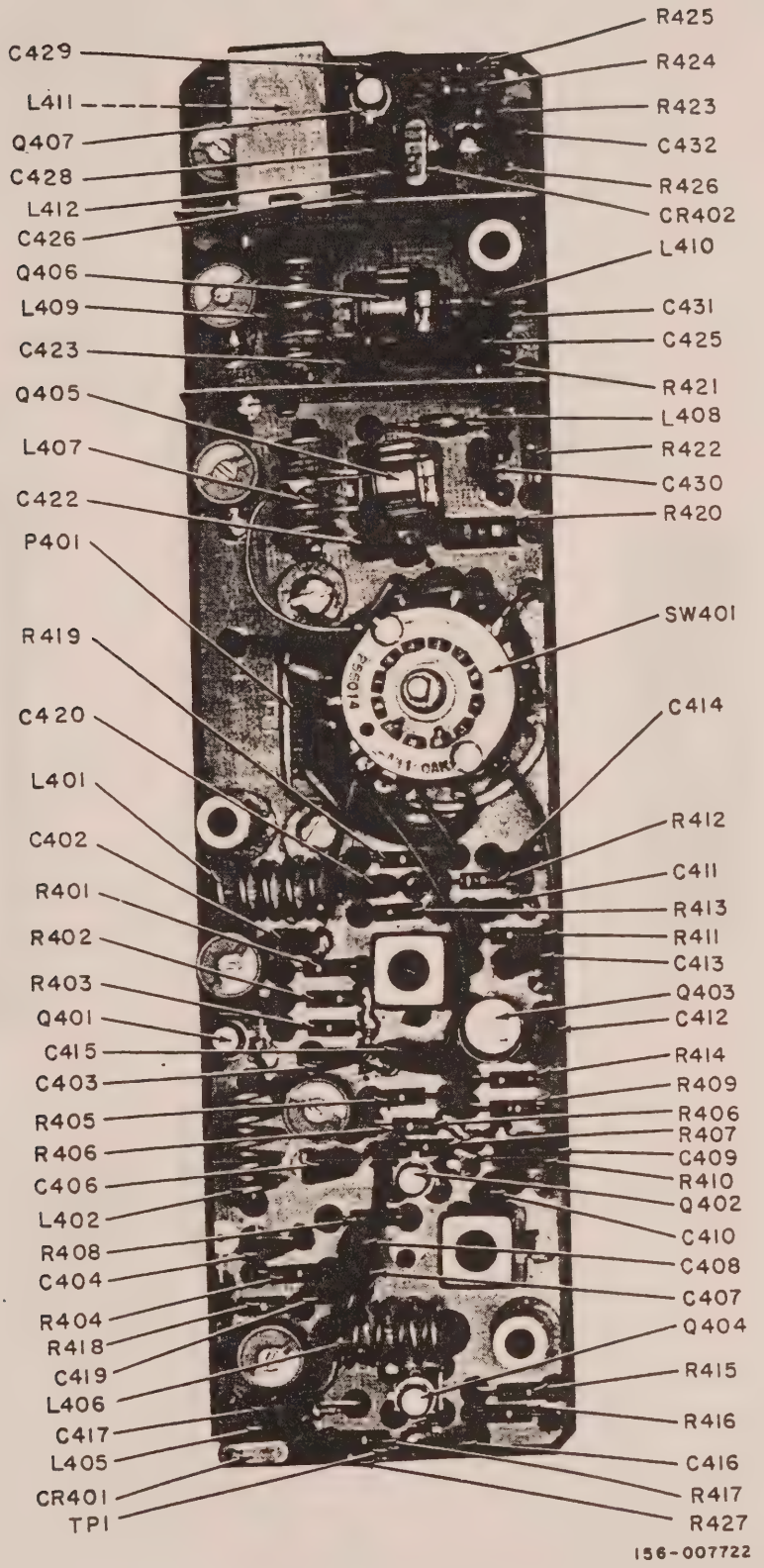


Figure 12. Component Locations (Air/Ground Adapter Printed Circuit Board).

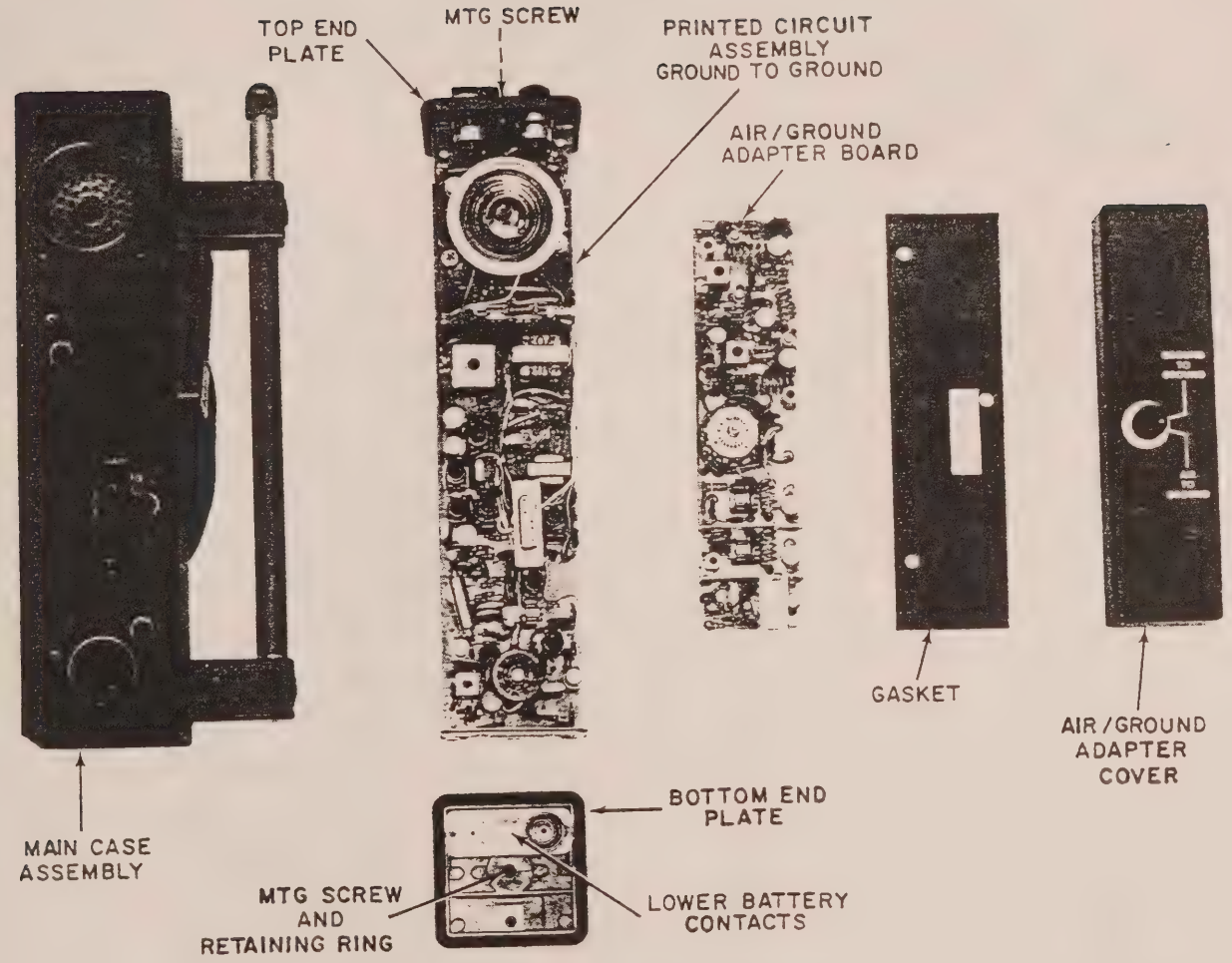


Figure 13. Transceiver Disassembly.

Table VI. Transceiver Voltage Measurements.

NOTE

The voltage measurements listed below were made with a vacuum tube voltmeter. As readings may vary slightly from one unit to another they should be considered as approximate values. Measurements were made with the TS-20/35 Test Set disconnected and all controls in their normal receive condition (no signal), unless otherwise noted. All measurements are listed in DC voltages between circuit ground (+) positive terminal of battery and point indicated.

	DC Base Voltage	DC Collector Voltage	DC Emitter Voltage
RF Amplifier Q1	-1.8	-11.0	-1.7
1st Converter Q2	-1.95	-11.2	-1.85
2nd Converter Q3	-1.85	-10.5	-1.8
1st 455 KC IF Amplifier Q4	-2.4	-6.4	-1.95
2nd 455 KC IF Amplifier Q5	-1.8	-10.5	-1.6
*Squelch Amplifier Q6	-2.15	-10.15	-3.4
*1st Audio Amplifier Q7	-4.5	-7.0	-4.4
Driver Amplifier Q8	-1.25	-9.3	-1.2
Audio Output and Modulator Q9	-6.15	-11.9	-5.8
Audio Output and Modulator Q10	-0.01	-6.0	0
**Transmitter Oscillator Q11	-11.0	0	-10.4
**Transmitter Power Amplifier Q12	-11.6	0	-11.6
RF Amplifier Q401	-5.0	-9.2	-4.6
Mixer Q402	-1.8	-9.5	-1.8
IF Amplifier Q403	-1.0	-9.6	-0.9
Local Oscillator Q404	-3.0	-9.0	-3.2
Transmitter Power Amplifier Q405	-10.0	0	-10.0
Transmitter Driver Q406	-10.0	0	-10.0
Transmitter Oscillator Q407	-8.6	0	-8.6

*Squelch control off, squelch "open" (extreme clockwise position).
**Push-to-talk button pressed, crystal CR3 removed from socket.

CURRENT MEASUREMENTS

	Ground to Ground	Air to Ground
Receiver, No Signal	25 MA	35 MA
Receiver, Average Input Signal, Max Audio Output	80 MA	90 MA
Transmitter Current, 0.5 Watt Nominal Output Carrier Only	180 MA	170 MA
Transmitter Current, 0.5 Watt Nominal Output with Peak Modulation	250 MA	220 MA

SECTION VI

PARTS LIST

NOTE

Components with reference designations from 1 to 99 are part of the removable printed circuit board. Components with reference designations from 101 to 199 are accessory items. Components with reference designations from 201 to 299 are part of the Test Set TS-20/35. Components with reference designations from 301 to 399 are part of Test Set adapter. Components with reference designations from 401 to 499 are part of Air/Ground Adapter.

Reference Symbol	Description	Part Number
C1	CAPACITOR, Mica, 68 PF, 5%, 300 VDCW	493-110680-223
C2	CAPACITOR, Ceramic, 0.002 UF, 600 VDCW	047-001704
C3	CAPACITOR, Ceramic, 0.01 UF, 20%, 50 VDCW	047-001703
C4	Same as C3	
C5	CAPACITOR, Mica, 110 PF, 5%, 300 VDCW	493-110111-224
C6	CAPACITOR, Mica, 120 PF, 5%, 300 VDCW	493-110121-224
C7	CAPACITOR, Ceramic, 0.001 UF, 500 VDCW	047-001671
C8	Same as C6	
C9	CAPACITOR, Mica, 150 PF, 5%, 300 VDCW	493-110151-224
C10	Same as C9	
C11	CAPACITOR, Mica, 300 PF, 2%, 300 VDCW	493-110301-324
C12	Same as C3	
C13	CAPACITOR, Electrolytic, 22 UF, 15 VDCW	045-001955
C14	Same as C3	
C15	CAPACITOR, Ceramic, 0.1 UF, 25 VDCW	047-001705
C16	Same as C15	
C17	Same as C15	
C18	Same as C3	
C19	Same as C3	
C20	CAPACITOR, Electrolytic, 25 UF, 12 VDCW, polarized	045-000949
C21	CAPACITOR, Electrolytic, 5 UF, 12 VDCW, non polarized	045-000954
C22	CAPACITOR, Electrolytic, 5 UF, 12 VDCW, polarized	045-000953
C23	CAPACITOR, Electrolytic, 5 UF, 12 VDCW, polarized	045-000952
C24	Same as C3	
C25	Same as C23	
C26	Same as C22	
C27	CAPACITOR, Mylar, 0.047 UF, 100 VDCW	046-001450
C28	Same as C2	
C29	Same as C23	

Reference Symbol	Description	Part Number
C30	CAPACITOR, Electrolytic, 25 UF, 12 VDCW, polarized	045-000951
C31	Same as C30	
C32	Same as C3	
C33	CAPACITOR, Electrolytic, 50 UF, 12 VDCW, polarized	045-000950
C34	CAPACITOR, Electrolytic, 100 UF, 12 VDCW, polarized	045-000955
C35	CAPACITOR, Mica, 82 PF, 5%, 300 VDCW	493-110820-223
C36	CAPACITOR, Mica, 18 PF, 5%, 300 VDCW	493-110180-221
C37	Same as C3	
C38	Same as C34	
C39	Same as C3	
C40	CAPACITOR, Mica, 100 PF, 5%, 300 VDCW	493-110101-224
C41	CAPACITOR, Mica, 33 PF, 5%, 300 VDCW	493-110330-223
C42	Same as C2	
C43	Same as C2	
C44	CAPACITOR, Electrolytic, 5 UF, 20 VDCW, polarized	045-000990
C45	CAPACITOR, Mica, 130 PF, 2%, 300 VDCW	047-001722
C46	CAPACITOR, Mica, 34 PF, 2%, 300 VDCW	493-110340-323
C47	Same as C44	
C48	CAPACITOR, Ceramic, 0.05 UF, 20%, 25 VDCW	047-002794-019
C49	Same as C7	
C50	Same as C48	
C51	CAPACITOR, Mica, 270 PF, 200 VDCW	047-002797
CR1	CRYSTAL, Quartz, HC-25/U case, plug-in receiver channel frequency desired -14.4 MC	019-003040
CR2	CRYSTAL, Quartz, HC-18/U case, solder lugs, mixer crystal 13.945 MC	019-003038
CR3	CRYSTAL, Quartz, HC-25/U case, plug-in receiver frequency = c.ystal frequency	019-003039
D1	DIODE, 1N270	019-005141
D2	Same as D1	
D3	DIODE, 1N295	019-301980
D4	Same as D3	
E1	ANTENNA, Telescoping	057-000433
F1	FUSE, 1/8 AMP	039-000751
FL1	FILTER, Ladder, 455 KC	049-000343
J1	PLUG, Modified	150-006210
J2	CONNECTOR, Antenna	010-002663
J3	JACK, Miniature phone	036-000347
LS1	SPEAKER, 2 inch	085-000293
L1	COIL, Antenna	051-003638

Reference Symbol	Description	Part Number
R54	RESISTOR, 47 ohm, 10%, 1/4W	451-152470
R55	RESISTOR, 330 ohm, 10%, 1/4W	451-152331
R56	RESISTOR, 10 ohm, 5%, 1/4W	451-152100
R57	Same as R46	
R58	Same as R46	
R59	Same as R28	
R60	Same as R3	
R61	Same as R6	
R62	Same as R1	
R63	RESISTOR, 5.6K ohm, 10%, 1/4W	451-152562
R64	Same as R3	
S1	SOCKET, Test	006-001079
S2	CONNECTOR, Female	010-003668
S3	TERMINAL, Receptacle	011-001359
SW1	SWITCH, SPST, P/O R31	
SW2	SWITCH, Push-to-Talk	060-002576
SW3	SWITCH, DESTRUCT, N/O	060-002583
T1	TRANSFORMER, IF output, 455 KC	050-002719
T2	TRANSFORMER, Driver	055-000488
T3	TRANSFORMER, Output	055-000487
	EARPHONE, External	085-000229

P/O ACCESSORY CABLE, MODEL RA-3

D101	DIODE, Germanium, power, 1N91	019-001897
F101	FUSE, Cartridge, 1 AMP, 3 AG	039-000306
J101	CONNECTOR, Receptacle, female, phono, with cable	087-008164
	CLIP, Battery, Negative	076-004501
	CLIP, Battery, Positive	076-004502

P/O TEST SET TS-20/35

J201	SOCKET, Pin	010-003468
M201	METER, 0-500 Microamperes	082-000691
P201	CONNECTOR, Plug, 11 pin, male, W/keyway	006-200793
R201	RESISTOR, 270 ohm, 5%, 1/2W	451-251271
R202	RESISTOR, 1.2 megohm, 5%, 1W	451-351125
R203	RESISTOR, 47K ohm, 5%, 1/2W	451-251473
R204	RESISTOR, 56K ohm, 5%, 1/2W	451-251563
R205	RESISTOR, 470 ohm, 5%, 1/2W	451-251471

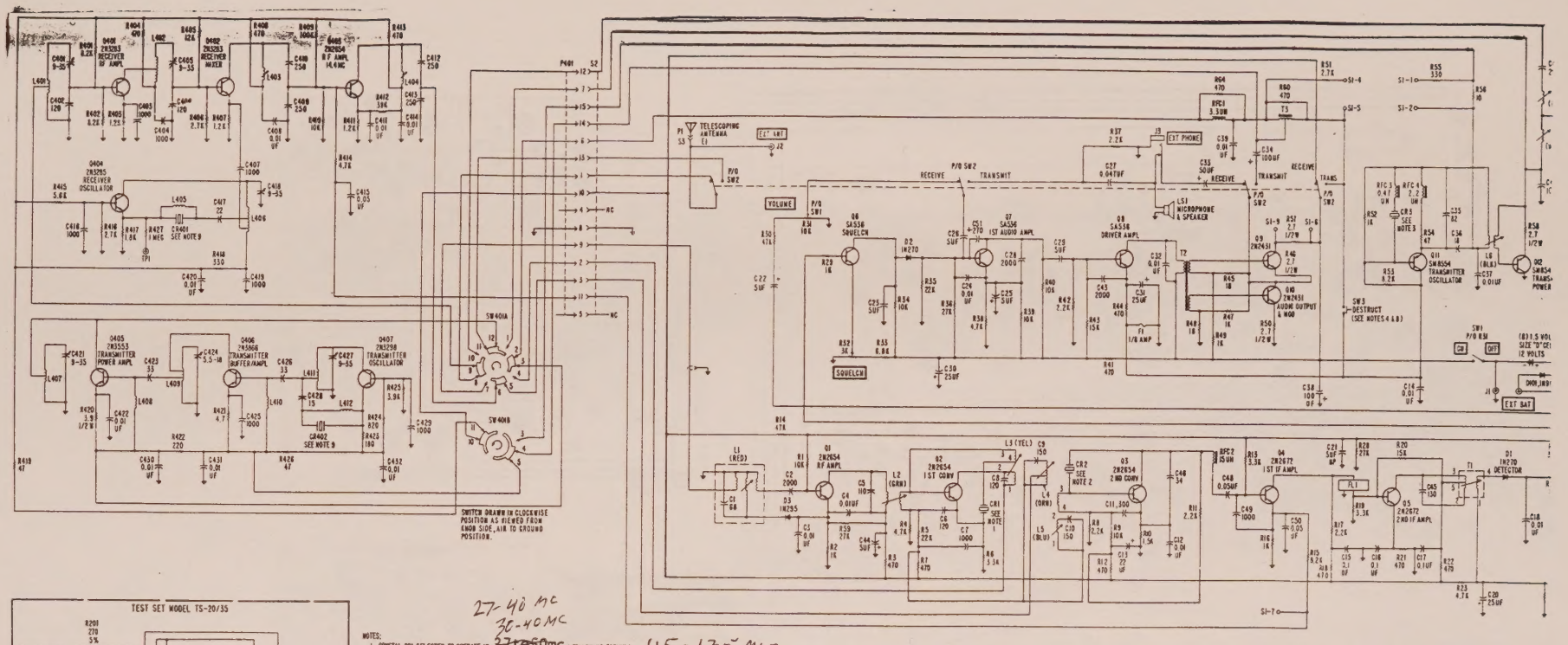
Reference Symbol	Description	Part Number
R206	RESISTOR, 5600 ohm, 5%, 1/2W	451-251562
R207	RESISTOR, 33K ohm, 5%, 1/2W	451-251333
SW201	SWITCH, Rotary, 2 pole, 8 position	060-002686
	ACCESSORY KIT, MODEL K-1	
	Test Set Adapter Cable	087-009007
P301	PLUG, Tip, P/O Test Set Adapter Cable	010-003467
P302	SOCKET, 11 Pin, P/O Test Set Adapter Cable	006-001063
P303	PLUG, 9 Pin, W/Cap, P/O Test Set Adapter Cable	010-003006
	TEST PLUG	150-016238

AIR/GROUND ADAPTER

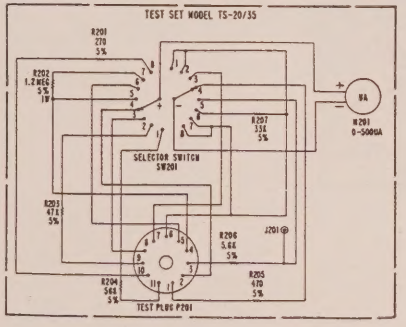
C401	CAPACITOR, Variable, Ceramic, 9-35 PF	044-000647
C402	CAPACITOR, Mica, 120 PF, 2%, 100 VDCW	493-910121-314
C403	CAPACITOR, Ceramic, 0.001 UF, 20%, 500 VDCW	047-001671
C404	Same as C403	
C405	Same as C401	
C406	Same as C402	
C407	Same as C403	
C408	CAPACITOR, Ceramic, 0.01 UF, 20%, 50 VDCW	047-001703
C409	CAPACITOR, Mica, 250 PF, 5%, 100 VDCW	493-910251-214
C410	Same as C409	
C411	Same as C408	
C412	Same as C409	
C413	Same as C409	
C414	Same as C408	
C415	CAPACITOR, Ceramic, 0.05 UF, 20%, 25 VDCW	047-002794-019
C416	Same as C403	
C417	CAPACITOR, Mica, 22 PF, 5%, 100 VDCW	493-110220-211
C418	Same as C401	
C419	Same as C403	
C420	Same as C408	
C421	Same as C401	
C422	Same as C408	
C423	CAPACITOR, Mica, 33 PF, 5%, 100 VDCW	493-910330-213
C424	CAPACITOR, Variable, 5.5-18 PF	044-000615
C425	Same as C403	
C426	Same as C423	
C427	Same as C401	

Reference Symbol	Description	Part Number
C428	CAPACITOR, Mica, 15 PF, 5%, 100 VDCW	493-110150-211
C429	CAPACITOR, Ceramic disc, 0.001 UF, GMV, 500 VDCW	047-000230
C430	Same as C408	
C431	Same as C408	
C432	Same as C408	
CR401	CRYSTAL, RCVR, CR-56A/U, Crystal frequency equals channel frequency minus 14.4 MC	019-003863
CR402	CRYSTAL, XMTR, CR-56A/U, Crystal frequency equals channel frequency	019-003922
L401	COIL, Antenna	050-002580
L402	Same as L401	
L403	COIL, IF	050-002693
L404	Same as L403	
L405	COIL, Receiver crystal	050-002712
L406	Same as L401	
L407	Same as L401	
L408	COIL, Transmitter, RF	050-003469
L409	Same as L401	
L410	COIL, Transmitter, RF	050-002584
L411	Same as L401	
L412	Same as L410	
P401	CONNECTOR, Male	010-003669
Q401	TRANSISTOR, 2N3283	019-003861
Q402	Same as Q401	
Q403	TRANSISTOR, 2N2654	019-003383
Q404	TRANSISTOR, 2N3285	019-003866
Q405	TRANSISTOR, 2N3553	019-005051
Q406	TRANSISTOR, 2N3866	019-003864
Q407	TRANSISTOR, 2N3298	019-003865
R401	RESISTOR, 8.2K ohm, 10%, 1/4W	451-152822
R402	Same as R401	
R403	RESISTOR, 1.2K ohm, 10%, 1/4W	451-152122
R404	RESISTOR, 470 ohm, 10%, 1/4W	451-152471
R405	RESISTOR, 12K ohm, 10%, 1/4W	451-152123
R406	RESISTOR, 2.7K ohm, 10%, 1/4W	451-152272
R407	Same as R403	
R408	Same as R404	
R409	RESISTOR, 100K ohm, 10%, 1/4W	451-152104
R410	RESISTOR, 10K ohm, 10%, 1/4W	451-152103

Reference Symbol	Description	Part Number
R411	Same as R403	
R412	RESISTOR, 39K ohm, 10%, 1/4W	451-152393
R413	Same as R404	
R414	RESISTOR, 4.7K ohm, 10%, 1/4W	451-152472
R415	RESISTOR, 5.6K ohm, 10%, 1/4W	451-152562
R416	Same as R406	
R417	RESISTOR, 1.8K ohm, 10%, 1/4W	451-152182
R418	RESISTOR, 330 ohm, 10%, 1/4W	451-152331
R419	RESISTOR, 47 ohm, 10%, 1/4W	451-152470
R420	RESISTOR, 3.9 ohm, 10%, 1/2W	451-252039
R421	RESISTOR, 4.7 ohm, 10%, 1/4W	451-152047
R422	RESISTOR, 220 ohm, 10%, 1/4W	451-152221
R423	RESISTOR, 180 ohm, 10%, 1/4W	451-152181
R424	RESISTOR, 820 ohm, 10%, 1/4W	451-152821
R425	RESISTOR, 3.9K ohm, 10%, 1/4W	451-152392
R426	Same as R419	
R427	RESISTOR, 1 megohm, 10%, 1/4W	451-152105
SW401	SWITCH, Rotary	060-002879

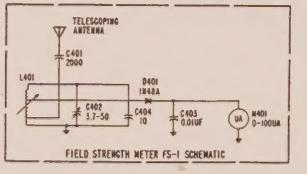


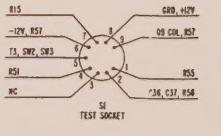
SWITCH DRAWN IN CLOCKWISE POSITION AS VIEWED FROM KNOB SIDE, AIR TO GROUND POSITION.

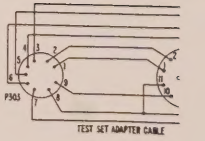


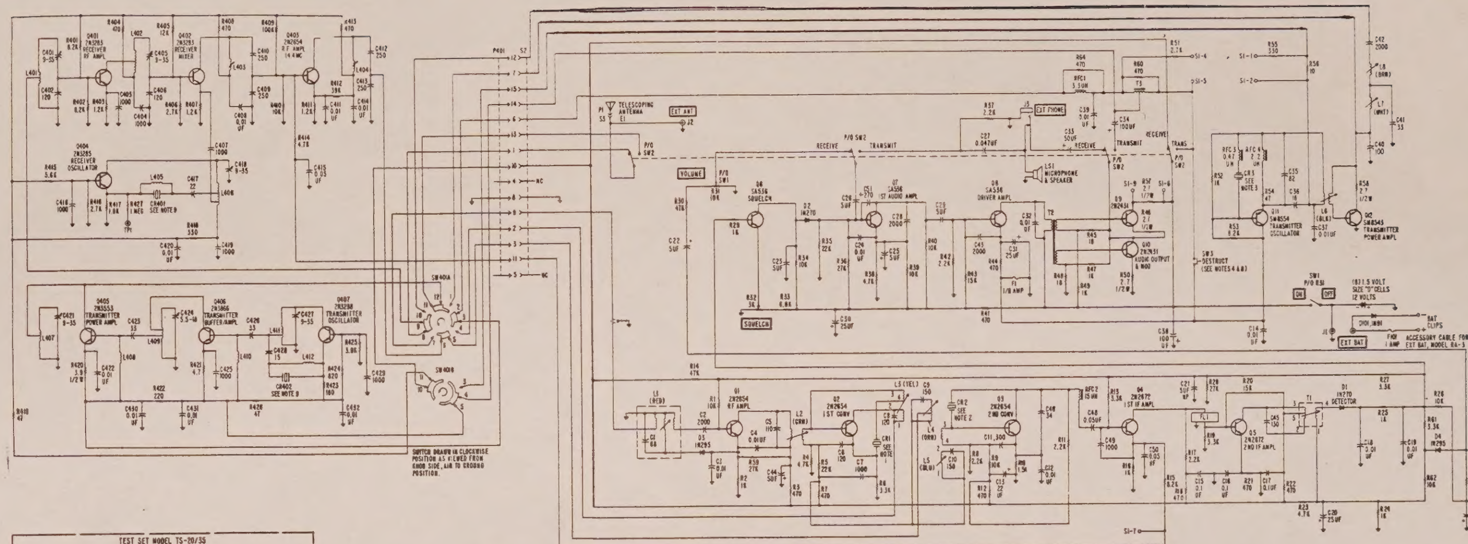
NOTES:

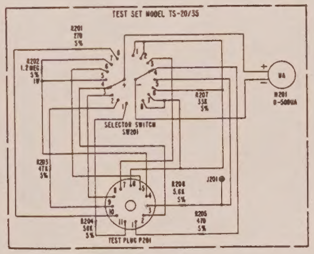
1. CRYSTAL CR1 SELECTED TO OPERATE IN ~~27.050MC~~ 27.40 MC 30-40MC 115-135 MHz. FOLLOWING FORMULA: RECEIVER OSCILLATOR FREQUENCY-OPERATING FREQUENCY-14.400 MC.
2. CRYSTAL CR2 13.945 MC.
3. CRYSTAL CR3 SELECTED FOR DESIRED CHANNEL IN ~~27.050MC~~
4. DESTRUCT SWITCH SW3 MOUNTED ON CASE, PUSH-TO-TALK SWITCH SW2 MUST BE IN TRANSMIT POSITION TO COMPLETE DESTRUCT CIRCUIT.
5. CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
6. RESISTANCE VALUES ARE IN OHMS, K=1000. ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE NOTED.
7. C45-130 PF IS LOCATED IN T1 ON SOME PRODUCTION RUNS.
8. DESTRUCT CIRCUIT OMITTED ON SOME SETS, F1 IS OMITTED, REPLACED BY JUMPER WIRE ON THESE SETS.
9. CRYSTAL CR401 SELECTED TO OPERATE IN 115 TO 135 MC RANGE BY THE FOLLOWING FORMULA: RECEIVER OSCILLATOR FREQUENCY-OPERATING FREQUENCY-14.400 MC. CRYSTAL CR402 SELECTED FOR DESIRED CHANNEL IN 115 TO 135 MC RANGE.











NOTES:

1. CRYSTAL CR1 SELECTED TO OPERATE IN 27to50mc FOLLOWING FORMULA: 115-135 MHz
   RECEIVER OSCILLATOR FREQUENCY=OPERATING FREQUENCY-14.400 MC.
2. CRYSTAL CR2 13.945 MC.
3. CRYSTAL CR3 SELECTED FOR DESIRED CHANNEL IN : 27to50mc
4. DESTRUCT SWITCH SW3 MOUNTED ON CASE, PUSH-TO-TALK SWITCH SW2 MUST BE IN TRANSMIT POSITION TO COMPLETE DESTRUCT CIRCUIT.
5. CAPACITANCE VALUES ARE IN PICOFARADS UNLESS OTHERWISE NOTED.
6. RESISTANCE VALUES ARE IN OHMS, K=1000. ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE NOTED.
7. C45-130 PF IS LOCATED IN T1 ON SOME PRODUCTION RUNS.
8. DESTRUCT CIRCUIT OMITTED ON SOME SETS, F1 IS OMITTED, REPLACED BY JUMPER WIRE ON THESE SETS.
9. CRYSTAL CR401 SELECTED TO OPERATE IN 115 TO 135 MC RANGE BY THE FOLLOWING FORMULA: RECEIVER OSCILLATOR FREQUENCY=OPERATING FREQUENCY-14.400 MC. CRYSTAL CR402 SELECTED FOR DESIRED CHANNEL IN 115 TO 135 MC RANGE.